Land Evaluation for agricultural purposes - Bulgarian system
PART II. Evaluation scales according to winter wheat requirements

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1. Abstract

The methods and approaches for evaluating the lands in Bulgaria according to the winter wheat requirements are demonstrated here. The Bulgarian system is using parametric method and uses important characteristics of the land–soil, relief, and climate according to the pre-developed scales. A high satisfactory level is reached about the adequacy of the relative evaluation. An example is shown.

2. Introduction

The Bulgarian system for evaluation of lands supposes working with pre-set algorithms and evaluating scales (based on these algorithms), map material, etc. The structure of the system itself supposes periodic update based on newly acquired data, changes in the hybrid composition of the cultures, developing on more accurate methods for research, etc. The scales shown below are part of the current updated contingent. (Georgiev, 1988). A good premise for adequate work during the development and usage of the corresponding methods for evaluation, discussed below is the presence of a database both of the soil (done with large scale soil mapping) and of the correct long term climate data of Bulgaria, covering the whole country. The purpose of the current development is to show the algorithms of the Bulgarian land evaluating system during the evaluation of agricultural lands according to the requirements for winter wheat.

3. Methods

Seven main evaluating scales, show below, have been developed for the estimating of the winter wheat.

Evaluation scale 1 (direct ratings): this scale is used for evaluation several soil characteristics. A specific feature of rock is that with evaluation of the soil texture in cases of heavy sandy soils (sands of percentage of physical clay – particles<0.01 mm) the result could be 0.00. In such cases all other components of evaluation are ignored and the total result (the Field Rating Number) is 0,00.

Table 1a Evaluation Scale 1 in Bulgarian System for Land Evaluation

Characteristics	Values			Ratings	Notes
		R_{TX}			
Texture Clay content (%) (Katchinsky classification)	0.0	÷	5	0	With underground water not deeper than 100 – 200 cm, all soils, with the exception of salty, gravy, and sandy, as well as lightly clay, get the value of the index equal to 100.
	5.1	÷	10	10	
	10.1	÷	20	30	
	20.1	÷	30	60	
	30.1	÷	45	80	
	45.1	÷	60	100	
	60.1	÷	75	80	
		>	75	70	
		R_{THH}			
Thickness of humus horizon (cm)	1	÷	20	40	
	21	÷	40	80	
		>	40	100	
		R_{TSP}			
Thickness of soil profile (cm)	1	÷	30	10	Only for shallow soil developed on hard rock. The values are doubled.
	31	÷	50	30	

Table 1b Evaluation Scale 1 in Bulgarian System for Land Evaluation

Characteristics	Values			Ratings	Notes
			R_{CCR}		
Clay content ratio		<	1.00	80	
Clay content in A horizon %	1.01	÷	1.30	100	
Clay content in B horizon %	1.31	÷	2.00	90	
		>	2.00	40	
			R_{pH}		
Soil Reaction		>	7.50	80	
(pH in H_2O)	6.50	÷	7.49	100	
	5.00	÷	6.49	90	
		<	4.99	50	
			R_{HC}		
Humus content (%)		<	1.00	40	
(after Turin method)	1.01	÷	2.00	70	
	2.01	÷	3.00	95	
		>	3.00	100	
			R_{GWT}		
Ground water table (cm)	0	÷	50	30	For salty meadow, gravy, and sandy
	51	÷	100	80	soils with underground water, deeper
	101	÷	200	100	than 100 cm, the index is not evaluated.

Evaluation scale 2 (k_{EA}): in order to work with scale 2, referring to evaluation of erosion and accumulation we use Agronomic Grouping of Soils in Bulgaria (Yolevski & Hadzhiyanakiev, 1976) in which soils are grouped according to their production qualities irrespective of soil classification. 11 agro-soil groups have been established – 01; 02;; 03; 04; 05; 06; 07; 08; 09; 10 and 06; 07; 08; 09; 10 and 11. Apart from that according to the indication of processes, soils in Bulgaria are graded as follows – non-erosion, first, second or third degree of erosion or in an analogous way - accumulated.

Table 2 Evaluation Scale 2 in Bulgarian System for Land Evaluation

Degree of erosion	Agrosoil groups and coefficients k_{EA}			
or accumulation	01 and 10	02, 03 and 06	04 and 07	05, 08, 09 and 11
Erosion:				
No erosion (E^0)	1.00	1.00	1.00	1.00
First degree (E^I)	0.90	0.95	0.85	0.80
Second degree (E^{II})	0.70	0.75	0.65	0.60
Third degree (E^{III})	0.60	0.65	0.55	0.55
Accumulation:				
No accumulation (A^0)	1.00	1.00	1.00	1.00
First degree (1 ÷ 20 cm)	1.10	1.05	1.05	1.00
Second degree (20 ÷ 50 cm)	1.30	1.10	1.10	1.05
Third degree (>50 cm)	1.50	1.30	1.30	1.10

Evaluation scale 3 (k_{SA}): scale 3 contains correction coefficients for saltines/alkaline of the soil according to the requirements for winter wheat:
1. not salty   water soluble salts   <0.3 %   exchangeable Na   < 5 %
2. lightly salty   water soluble salts 0.3-0.5 %   exchangeable Na   5-10 %
3. mid-salty   water soluble salts 0.5-0.8 %   exchangeable Na 10-15 %
4. heavy salty   water soluble salts 0.8-1.0 %   exchangeable Na 15-20 %
5. strongly salty   water soluble salts   >1.0 %
6. very strongly salty   exchangeable Na   >20%

Table 3 Evaluation Scale 3 in Bulgarian System for Land Evaluation

Degree of salinity/alkalinity and coefficients k_{SA}					
1	2	3	4	5	6
1.00	0.90	0.80	0.70	0.10	0.10

Evaluation scale 4 (k_{ST}): according to standards accepted by Bulgarian soil-study scientists the degrees of soil stoniness are as follows:

Degree of stoniness	1. None	2. Weak	3. Middle	4. Strong	5. Very Strong
Stones in plow layer (vol. %)	< 1	1 to 10	10 to 20	20 to 40	over 40

Table 4 Evaluation Scale 4 in Bulgarian System for Land Evaluation

Degree of stoniness and coefficients k_{ST}				
1	2	3	4	5
1.00	0.90	0.70	0.20	0.00

Evaluation scale 5 (k_{FL}): scale 5 displays the degrees of flooded land and correction coefficients k_{FL} with land evaluation according to requirements of winter wheat.. In standards accepted by Bulgarian soil-study scientists the degree of soil flooding are as follows:

Degree of flooding	1. None	2. Weak	3. Middle	4. Strong
Ground water table (cm)	> 100	50 to 100	30 to 50	< 30

Table 5 Evaluation Scale 5 in Bulgarian System for Land Evaluation

Degree of flooding and coefficients k_{FL}			
1	2	3	4
1.00	0.90	0.40	0.00

Evaluation scale 6 (k_{CL}): this is a scale of climatic correction coefficients. As a climatic characteristics connected with winter wheat requirements the balance of humidity for the period April-June is evaluated. It is the difference between the amounts of rainfall and evaporability (Ivanov, 1941). The evaluation algorithm is shown in the scale below. A map of agro-climatic regions for growing winter wheat in Bulgaria has been made and it contains climatic correction coefficients. The system also displays compatibility of these results with relief in reference to the situation of the slope and the position of the evaluated site on it.

Table 6 Evaluation Scale 6 in Bulgarian System for Land Evaluation

Moisture balance April - June (mm)	Map region N^0	Coefficients (k_{CL})
-100 to 0	1	1.00
-150 to -100	2	0.90
under -150	3	0.80
>0	4	0.80
Places with altitude higher than 1400 - 1600 m	5	0.00

Evaluation scale 7 (k_{IR}): the scale serves for finding the correction coefficient with irrigated land evaluation. In order to use this evaluation it is necessary to localize the object with reference to the special agro-ecological region establishment in Bulgaria (Yolevski et al., 1980). The territory of the country is divided into 7 groups of agro-ecological regions and a great number of sub-regions according to the specific combination of soil and climatic conditions. Apart from that the soil texture in plough layers and the degree of water availability are taken into consideration. As far as wheat growing is concerned the seventh group of agro-ecological regions (VII_1, VII_2 and VII_3) are situated at considerable height and with them no irrigation evaluation is done.

Table 6a Evaluation Scale 6 in Bulgarian System for Land Evaluation

Region	Clay content (%) and k_{IR}			Region	Clay content (%) and k_{IR}			Region	Clay content (%) and k_{IR}		
	<30	30 ÷ 60	>60		<30	30 ÷ 60	>60		<30	30 ÷ 60	>60
I_1	1.32	1.27	1.23	III_1	1.23	1.18	1.13	V_1	1.31	1.26	1.21
I_2	1.30	1.25	1.20	III_2	1.23	1.18	1.13	V_2	1.30	1.25	1.20
I_3	1.29	1.24	1.19	III_3	1.25	1.20	1.15	V_3	1.30	1.25	1.20
I_4	1.32	1.27	1.23					V_4	1.28	1.23	1.18
I_5	1.28	1.23	1.18	IV_1	1.28	1.23	1.18	V_5	1.31	1.26	1.21
I_6	1.28	1.23	1.18	IV_2	1.29	1.24	1.19	V_6	1.30	1.25	1.20
I_7	1.27	1.22	1.17	IV_3	1.23	1.23	1.18				
I_8	1.32	1.27	1.23	IV_4	1.30	1.25	1.20	VI_1	1.22	1.18	1.13
I_9	1.32	1.27	1.23	IV_5	1.28	1.23	1.18	VI_2	1.25	1.20	1.15
I_{10}	1.32	1.27	1.23	IV_6	1.30	1.25	1.20	VI_3	1.28	1.23	1.18
I_{11}	1.30	1.25	1.20	IV_7	1.32	1.27	1.23	VI_4	1.28	1.23	1.18
				IV_8	1.29	1.24	1.19	VI_5	1.28	1.23	1.18

Table 6b Evaluation Scale 6 in Bulgarian System for Land Evaluation

II_1	1.27	1.22	1.17	IV_9	1.30	1.25	1.20	VI_6	1.28	1.23	1.18
II_2	1.28	1.23	1.18	IV_{10}	1.28	1.23	1.18	VI_7	1.26	1.21	1.16
II_3	1.27	1.22	1.17	IV_{11}	1.31	1.26	1.21				
II_4	1.28	1.23	1.18	IV_{12}	1.31	1.26	1.21	VII_1	none	none	none
II_5	1.28	1.23	1.18					VII_2	none	none	none
II_6	1.24	1.19	1.14					VII_3	none	none	none
II_7	1.27	1.22	1.17								
II_8	1.30	1.25	1.20	If no irrigation k_{IR} = 1.00							

4. Results

As a conclusion we will demonstrate an example of a concrete evaluation of land according to the requirements for winter wheat.

Table 7 Example of initial data in Bulgarian System for Land Evaluation

Characteristics	Data	Symbols	Ratings/coefficients
Texture - clay content (%)	48	R_{TX}	100
Thickness of humus horizon (cm)	30	R_{THH}	80
Thickness of soil profile (cm)	240	R_{TSP}	None (deep profile)
Clay content ratio	1.25	R_{CCR}	100
Soil Reaction (pH in H_2O)	6.60	R_{pH}	100
Humus content (%)	2.80	R_{HC}	95
Ground water table - GWT (cm)	> 800	R_{GWT}	None (deep GWT)
Agrosoil group 01, degree of erosion – none	E^0	k_{EA}	1.00
Water soluble salts/exchangeable Na (%)	<0.3/<5	k_{SA}	1.00
Degree of stoniness (%)	12	k_{ST}	0.70
Degree of flooding (cm)	>100	k_{FL}	None (deep GWT)
Moisture balance April - June (mm)	-180	k_{CL}	0.80
Irrigation (region I_8)	No irrigation	k_{IR}	1.00

The main equation (1) is used for acquiring the final estimation:

$$FR = \frac{R_{TX} + R_{THH} + R_{TSP} + R_{CCR} + R_{pH} + R_{HC} + R_{GWT}}{n^R} k_{EA}\,k_{SA}\,k_{ST}\,k_{FL}\,k_{CL}\,k_{IR} \qquad (1)$$

Where: FR = Field Rating; R. and k. = Values from the show evaluation scales; n^R = Number of participants in the estimation.

According to the data in Table 1, when we eliminate the values that are not estimated and the coefficients equal to 1.00, the main equation is reduced to:

$$FR = \frac{R_{TX} + R_{THH} + R_{CCR} + R_{pH} + R_{HC}}{n^R} k_{ST}\,k_{CL} \qquad (2)$$

The calculations in equation 3 gives a final value of – Field Rating 72.2 points.

$$FR = \frac{100 + 80 + 100 + 100 + 95}{5} * 0.7 * 0.8 = 72.2 \qquad (2)$$

According to Bulgarian classification, for winter wheat, growing in dry conditions, this is suitable land 2 group, category 3.

5. References

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